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COMPARATIVE LUMBER SELLING VALUES OF DIFFERENT
GRADES AND SIZES OF REDWOOD LOGS

Notes on a Preliminary Analysis of a Mill-Production Study in Humboldt
County Conducted in 1935

By

M. R. Brundage

Associate Forester, Section of Forest Products

Brief Description of Study

The mill-production study upon which this information is based was part of a selective logging study undertaken cooperatively by a redwood lumber company, the Section of Forest Management of Region 5, United States Forest Service, and the Experiment Station designated above. The California Redwood Association assigned one of their lumber inspectors to assist the mill-study crew.

On the logging area, located near Eureka, a virgin-timber plot of approximately 80 acres was surveyed and cruised preparatory to the planning of a tractor roading system. Trees were numbered and marked for cutting and time studies were made to determine the relative costs of logging different sizes of logs and trees. Results of the latter observations are now being compiled and will be reported upon later by another section of this Station.

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Each study-plot log was numbered to preserve its identity when delivered to the sawmill and descriptions of each were recorded before peeling and again at the mill after peeling. Many of the logs were graded also in the standing trees.

A mill-study crew was organized to scale the logs on the deck, time the sawing of each log at the headsaws, number the boards so that log identity would be carried through to the sorting table, and tally the lumber produced from each log by thickness, width, length and green lumber grade. Study logs were cut according to normal sawmill routine, i.e., there was no slowing down of usual production speed nor any change in the customary handling of the lumber and diversion of cants to the resaw. Study logs were routed to one headsaw at a time during most of the study period, the other of the two bands continuing its regular cutting of non-study logs.

Difficulties encountered in booming the proper proportions of study-plot and non-study-plot logs made it impossible to observe study-plot logs continuously while the study crew was on duty. To keep the crew busy, therefore, other logs were graded and tallied intermittently. Of the 542 logs observed during the mill study period, 211 did not originate on the study plot and consequently had no before-peeling grades or descriptions.

Tentative Log Grades

One of the major purposes of this milling study, and of others to be made by the Forest Service in the near future, is to provide accurate data for the formulation of redwood log-grade specifications which will reflect relative log values within limits as narrow as the variability of the species will permit. To this end, the descriptions that were made of each mill-study log as it was sent to the head saw, and of most study-plot logs before the bark was removed, were recorded in considerable detail. Intensive analysis of these data is just being started as this preliminary note is issued.

The results presented herewith are based only on a simple, tentative log-grade classification devised when the study was planned. Furthermore, with the exception of Grade 2, they are confined to the log grades assigned before the bark was peeled. So few logs were classified as Grade 2 in the woods that it was necessary to supplement them with non-study-plot logs graded as #2 on the mill deck, with bark removed, in order to provide enough points for curvilinear correlation of lumber grades and log diameter.

The tentative log-grade specifications follow:

GRADE 1. Clear or practically surface-clear logs. May have one thru-knot or one sap-knot, or both.

GRADE 2. Logs with not more than one thru-knot but having any number of sap-knots.

GRADE 3. Logs with two thru-knots. No limit on number of sap-knots.

GRADE 4. Thru-knots allowed in direct ratio to log diameter, the limit for any 16-foot log being determined by taking 1/10 of the diameter in inches and rounding off to the nearest whole figure.

For example:

37-inch log. $37/10 = 3.7$, round off to 4.

Maximum thru-knots permitted = 4.

62-inch log. $62/10 = 6.2$, round off to 6.

Maximum thru-knots permitted = 6.

No limit on number of sap-knots.

It will be noted that this grade conflicts with Grade 3 when a log is smaller than 26 inches in diameter. The Grade 4 rule should govern in such small sizes, i.e., logs 16 to 25 inches in diameter having 2 thru-knots should be graded as #4 rather than as #3.

GRADE 5. Logs having thru-knots exceeding in number the limits specified for Grade 4.

For logs longer than 16 feet the knot limits are to be increased proportionately. Thus, a 24-foot log may have 1-1/2 times the number of knots allowed in a 16-foot log, and a 32-foot log may have twice the 16-foot limits.

These rules are admittedly very sketchy and must frequently be supplemented by the personal judgment of the grader. For one thing, distribution of knots, both with reference to each other and to the ends of the log, is at least equal in importance to the number of knots. In the practical application of the rules to the logs in this study some allowance was made for the distribution variable, although probably not enough. Knots at the extreme ends, for example, were disregarded on some otherwise high-line logs which qualified as Grade 1, 2, or 3 without the end knots. Two or three knots close together, which would be no more serious than one large knot as a degrading factor, were occasionally counted as only one knot. These, and several other variations in knot location and knot size will be specifically covered in the new rules to be formulated from analysis of the detailed study data. Birds-eye, surface bumps other than sap-knots, burls, spiral grain, compression wood, shake, rot, and other defects will also be considered in the new classification.

Eventually there will probably be two distinct sets of rules, one for log-grading in the standing tree, or in down trees before peeling, and the other for peeled logs. For grading in the standing tree, only exterior surface appearance, of course, can be considered.

As additional criteria for determining the merchantability of bucked and peeled logs, however, a supplementary end-defect (rot, rift crack, etc.) classification should be appended; also surface defects which are not visible before bark-removal may call for some differences in surface specifications of peeled log grades.

Realization Values in Relation to Log Size and Grade

The lumber selling values of logs given in Table 1 were derived by application of the western selling-price lists, noted above the tabulation, directly to lumber grade-thickness-width-length segregations for 142 individual logs selected to yield a fairly representative sample of each 5-inch log diameter group in each log-grade. As stated previously, the log-grade segregations, with the exception of a few logs in Grade 2, are based exclusively on appearance before peeling in accordance with the tentative rules just outlined. The number of logs priced in each log size-grade class appears under each log-grade heading on line with each 5-inch group designation.

Individual values for each log grade were plotted over log diameter and free-hand curves were fitted. Average selling prices read from these curves appear in the columns headed "Average value, curved". The least valuable and the most valuable of the logs sampled in each 5-inch diameter group are noted in the columns headed "Range in individual log values".

Although the sample evaluated is limited to 43 percent of the total number of study-plot logs (or about 26 percent of all mill-study logs), it provides a reliable index to the general trends of the relation between log size and average realization value for each of the tentative log grades. The wide spread between high and low values of individual logs within some of the same diameter and log-grade segregations reflects, of course, the inadequacy of the tentative log-grading rules, but it is also important to bear in mind that some of the variability - a major share of it in some groups - is the result of variations in kind and degree of internal defects. Naturally there will be appreciable differences in average value between two logs, regardless of close similarity in size and external appearance, if one, for example, is practically sound and the other is riddled with splits and shakes, or if both are sound but one has severe compression wood and the other is soft textured. The relation between realization values and cull classes, and a complete analysis by peeled-log grades will be published in the final report of this study.

Average Lumber Grade Production by Log Size and Grade

The percent by volume of each grade of lumber in the green-tally recovery of #3 Common and Better was calculated for each study log. From these individual values, straight-line correlations between

log-diameter and average yields of each lumber grade were computed by the method of least squares for each log grade. The results, after making minor adjustments to balance the sum of the curved lumber-grade fractions for each log at exactly 100 percent, are shown by 5-inch diameter intervals in Table 2. A small volume of Prime Structural timbers is included with Clear Grade and some Select Structural is included with A Grade. Other combinations are noted at the foot of the table.

All of the 331 study-plot logs were used in computing the equations. In addition, 20 logs graded only after peeling were also included in the computations for log Grade 2. The reason for this has been mentioned in connection with the comments on Table 1. Only 6 logs from the study plot were graded as #2 with the bark on. Of the 6, one was graded as #2 at the mill after peeling, 3 were graded as #1, one as #3, and the other as #5. This sample is a slender basis for drawing conclusions, but at least it lends strength to the assumption that most of the larger Grade 2 peeled logs used in this analysis would probably have been classified as #1 before removal of bark. If this is the proper explanation of the similarity in the yields of lumber grades for log diameters 45 inches and larger in Grades 1 and 2, it would appear that a sap-knot grade is an unnecessary refinement for the normal run of redwood logs. The occasional log with an abnormal number of sap-knots should perhaps be dropped one grade after classifying it on the basis of thru-knots only, otherwise a limited number of sap-knots should probably be ignored.

Log Grade 3 differs little from log Grade 4 in yield of uppers (B Grade and Better). There are two reasons for this: first, the samples of each were inadequate, and, second, most of the logs in Grade 4 happened to have but one or two knots in excess of the two-knot limit specified for Grade 3.

It is obvious that these tentative rules can be considerably improved. These preliminary figures show some interesting trends, nevertheless, and may be of some value until the more intensive analysis provides the basis for a better classification.

TABLE 1 - PRELIMINARY ANALYSIS OF REDWOOD LOG REALIZATION VALUES.
LOGS GRADED BEFORE PEELING. NO SEGREGATION OF DEFECT CLASSES
Average selling values per M B.M. mill tally of the lumber cut
from different sizes and grades of redwood logs

Rough green selling prices, based on western Price List No. 10, including advances as listed in Supplement No. 4, June 13, 1935.
No. 3 Common prices as on Schedule #336-N, May 28, 1935 with deduction of \$6.00 for freight to S. F. and quantity discount (\$4.50 + \$1.50).

Log diam.	LOG GRADE 1		LOG GRADE 2		LOG GRADE 3	
	1/ Average value curved	2/ Range in individual log values	Average value curved	Range in individual log values	Average value curved	Range in individual log values
Inches	Dollars per M B.M.		Dollars per M B.M.		Dollars per M B.M.	
25	23.40	22.61 & 25.88	17.15	14.59 to 22.19	18.20	20.31
25-29		(2) 3/		(7) 22-29"		(1 log-29")
30	24.30	22.68 to 26.21	19.15	22.79 & 26.69	19.55	16.19 to 20.18
30-34		(3)		(2)		(4)
35	25.25	19.76 to 27.29	21.10	17.77 to 21.70	20.60	16.40 to 27.15
35-39		(5)		(4)		(3)
40	26.20	20.04 to 33.27	22.80	22.49	21.50	19.88 to 24.74
40-44		(5)		(1 log-40")		(5)
45	27.00	23.24 to 34.19	24.60	28.22	22.25	24.78 & 28.51
45-49		(4)		(1 log-47")		(2)
50	28.00	25.75 to 33.48	26.20	20.72 to 25.41	22.95	21.71 & 22.69
50-54		(5)		(3)		(2)
55	28.75	24.19 to 35.12	27.50	25.32 & 30.15	23.50	18.36 & 23.40
55-59		(4)		(2)		(2)
60	29.40	25.09 to 35.60	28.75	28.97 & 30.04	24.00	-
60-64		(4)		(2)		(0)
65	29.75	26.10 to 33.94	29.80	-	24.60	26.83
65-69		(5)		(Largest log sampled in Grade 2 was 62 inches)		(1 log-69")
70	30.00	23.70 to 36.70				
70-74		(5)				
75	30.00	24.38 to 34.20				
75-79		(3)				
80	30.00	28.45				
80-84		(1 log- 81")				
85	30.00	24.10 to 35.69				
85-89		(4)				
All sizes	28.96	19.76 to 36.70	24.23	14.59 to 30.15	22.53	16.19 to 28.51

1/ From free-hand curve plotted thru individual log-value points.

2/ Shows the selling values of the poorest and best logs in each 5-inch log-diameter group. Thus \$19.76 is the value per M mill tally of the poorest log and \$27.29 is the value of the best log evaluated in the 35 to 39-inch group of Grade 1. The lowest value and highest-value logs in the random samples of each log grade as a whole are shown at the bottom of the table.

3/ Numbers in parenthesis indicate number of logs sampled in the preliminary evaluation for each 5-inch group. Thus, the (2) at the left of footnote reference 3/ denotes 2 logs sampled in the 25 to 29-inch diameter group of Grade 1.

TABLE 1 (Continued)

Log diam.	LOG GRADE 4		LOG GRADE 5	
	1/ Average value curved	2/ Range in individual log values	Average value curved	Range in individual log values
Inches	Dollars per M B.M.		Dollars per M B.M.	
25	-	(Smallest log sampled-33")	16.40	13.64 to 20.22
25-29				(6) <u>3/</u>
30	16.70	18.35	16.70	14.88 to 19.28
30-34		(1 log-33")		(4)
35	17.50	12.30 to 21.98	17.20	12.97 to 18.68
35-39		(4)		(4)
40	19.00	17.11 to 21.93	17.80	14.47 to 18.01
40-44		(5)		(4)
45	20.70	19.57 & 20.68	18.50	16.62 to 23.30
45-49		(2)		(5)
50	22.20	19.99 & 25.73	19.25	16.84 to 24.56
50-54		(2)		(6)
55	23.50	22.71	20.00	-
55-59		(1 log- 57")		(0)
60	24.55	24.10	20.50	21.92
60-64		(1 log- 63")		(1 log- 61")
65	25.40	26.26		-
65-69		(1 log- 68")		(0)
70	25.90	-		18.94
70-74		(0)		(1 log- 74")
75	26.30	25.71		
75-79		(1 log- 79")		
80	26.50	27.24		
80-84		(1 log- 83")		
All sizes	22.27	12.30 to 27.24	18.60	12.97 to 24.56

(See footnotes under first part of table)

TABLE 2.- PERCENT OF EACH LUMBER GRADE PRODUCED FROM REDWOOD LOGS OF DIFFERENT DIAMETERS AND LOG GRADES. GREEN-CHAIN TALLY BASIS. PRELIMINARY ANALYSIS BY LEAST SQUARES STRAIGHT LINE METHOD.

Log Diam.	L u m b e r g r a d e s							#1 Ties
	Selects			Common			Shop	
	Clear	A	B	#1 ⁺	#2 ⁺⁺	#3 ⁺⁺⁺		
Inches	LOG GRADE I							
25	1.8	13.8	21.2	19.9	16.8	23.3	0.4	2.8
35	6.7	15.0	19.0	20.2	14.9	19.6	2.5	2.1
45	11.4	16.2	16.9	20.4	13.0	15.9	4.6	1.6
55	16.0	17.4	14.7	20.5	11.0	12.1	6.7	1.6
65	20.8	18.6	12.5	20.7	9.1	8.3	8.7	1.3
75	25.5	19.8	10.2	20.9	7.2	4.5	10.8	1.1
85	30.2	20.9	8.1	21.0	5.2	0.8	12.8	1.0
	LOG GRADE II							
25	-	4.5	11.0	21.3	16.4	45.0	1.75	.05
35	4.5	10.9	12.8	20.5	14.1	34.4	2.03	.77
45	10.0	17.3	14.4	19.6	11.7	23.8	2.30	.90
55	15.5	23.5	16.2	18.7	9.4	12.9	2.59	1.21
65	21.1	29.9	17.9	17.8	7.0	2.0	2.87	1.43
	LOG GRADE III							
25	1.1	8.2	18.4	12.8	12.7	42.5	4.3	-
35	4.9	10.2	16.8	14.9	11.6	37.1	4.2	0.3
45	8.7	12.3	15.7	17.1	10.5	27.8	4.0	3.9
55	12.5	14.3	14.6	19.1	9.3	18.7	3.8	7.7
65	16.3	16.3	13.6	21.2	8.4	9.5	3.7	11.0
75	20.1	18.4	12.4	23.3	7.1	0.3	3.5	14.9
	LOG GRADE IV							
25	4.3	8.4	16.3	3.6	8.8	46.1	12.5	-
35	6.6	11.0	15.5	8.6	9.2	38.7	10.4	-
45	8.8	13.5	14.6	13.7	9.5	31.6	8.3	-
55	11.0	16.2	13.8	18.8	9.9	22.2	6.2	1.9
65	13.3	18.8	13.0	23.8	10.2	12.4	4.0	4.5
75	15.6	21.3	12.1	28.8	10.6	5.3	1.9	4.4
85	17.7	23.9	11.3	33.8	11.1	-	-	2.2
	LOG GRADE V							
25	2.4	4.1	12.3	8.0	12.3	57.2	2.0	1.7
35	3.0	6.5	12.5	12.0	12.2	48.2	3.7	1.9
45	3.6	8.8	12.7	16.2	12.1	39.4	5.5	1.7
55	4.2	11.1	12.9	20.2	12.0	30.4	7.1	2.1
65	4.8	13.4	13.1	24.3	12.0	21.5	8.8	2.1
75	5.4	15.8	13.2	28.4	11.9	12.5	10.5	2.3

+ Includes #1 timbers.

++ Includes #2 timbers and #2 ties.

+++ Includes #3 timbers, #3 ties, and Bench grade.